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Improve Crop Production Through WSN: An Approach of Smart Agriculture

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Abstract

The goal is to build and create an agricultural monitoring system that uses a wireless sensor network to boost farming production and quality without having to manually monitor it all of the time. In agriculture, temperature, humidity, and carbon dioxide levels are the most critical elements affecting plant productivity, growth, and quality. As a result, this system measures these characteristics in the fields on a regular basis, allowing farmers or agriculture specialists to view the readings on the web at the same time. Furthermore, if a crucial change in one of the metrics occurs, an agriculture specialist will notify the farmer through mobile text message and e-mail. The farmer can study the best environmental conditions for maximum crop productivity, greater productivity, and significant energy savings by continuously monitoring several environmental data.

Keywords: Agricultural, Monitoring, Farming, Production, Temperature, Humidity, Elements, Productivity, Quality, Specialists, Crucial, Environmental.

1 | Introduction

In order for the automation system to function smoothly in an ultra-modern and huge green house, several measurement sites are required to determine the local conditions parameters at various locations. Using cabling for monitoring would increase the cost of the measuring system, make it more fragile, and make it more difficult to transfer measurement locations. Because of these concerns, creating the key parameter measurement system with a WSN constituted of small wireless sensor nodes with radio and sensors is a more cost-efficient, safer, and effective method. Farmers or agro specialists in an agriculture field can access data such as temperature and humidity levels inside the fields at any time via the internet. The enhancement of science and technology leads to make the life more comfortable than older days. The emerging technologies like software engineering [1] and [2], energy management [3], [4], [5], wireless sensor network [6]-[13], face recognition [15], neural network [15], routing [16] and [17], distributive environment [18], mixed environment [19] bellman algorithm [20], programming language [21], neutrosophic shortest path [22]-[24], optimal path [25], multi-objective optimal path [26], transportation problem [27]-[29], uncertainty problem [30]-[35], fuzzy

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shortest path [36] and [37], powershell [38], answer note [39], making the products more intelligent and self-healing based. The smart city [40] applications like smart water [40]-[43], smart agriculture [44] smart grid [39], smart parking [46], smart resource management, etc. are based on IoT [45]-[47] and IoE technologies. In addition, if one of the measurements changes significantly, the agriculture expert will notify the farmer by e-mail and SMS. As a result, the agriculture specialist can intervene as soon as possible in such a desperate scenario, avoiding potentially negative results of the alterations. A wireless sensor network is a collection of nodes that are densely put in an agricultural field to measure or monitor a variety of physical factors. Each of these nodes collects data and sends it back to a sink. While individual node locations are not predetermined, the network as a whole must be self-organizing. As a result, the most distinguishing feature of these networks is node cooperation, in which groups of nodes collaborate to broadcast information to the user that has previously been gathered in their region.

1.1 | Scope of the System

The first component of the system is a protocol. Under the star architecture, the sensor nodes do not communicate with one another, and each sensor only communicates with the gateway. Each node transmits data packets to the gateway, which assembles the data and sends it to the SQL database. The system's second component is the web application. After logging in, the user can browse all of the agricultural fields owned by farmers and choose one. On the next page, which displays the most current, the user can choose between past data, a graphical depiction, or the states of the sensor nodes. The user can view measurements and averages for a certain date, interval visualisations, and sensor node health information such as battery levels. There are different criteria for different greenhouses when it comes to measurements and ratios of dead sensors, and if the threshold is exceeded, the user is informed via email and SMS.

2 | Literature Survey

Sensor nodes can now be used in a wide range of applications, including environmental monitoring, homeland security, and disaster relief operations, thanks to the widespread adoption of low-cost sensor nodes in recent years. Their tremendous requirement for data collecting is one key contribution. In certain application domains, real-time data collecting is a more challenging and promising issue. In the literature, various methodologies and solutions for real-time data gathering have been offered. Wireless Sensor Networks (WSNs) are made up of a large number of small wireless sensors that operate in a given area to collect data for a specific objective. After sensor nodes are deployed in most types of WSNs, no additional activities are taken. Sensor nodes collect data from the environment in a typical WSN, which is then pooled in intermediary nodes before being transferred to a base station.

Because all these processes are carried out by sensor nodes with limited power in a wireless medium, challenges such as reliable communication, power efficiency, and network survival are major concerns. Because of their fundamental properties, WSNs differ from regular networks. WSNs can be applied to a wide range of situations. Networks made up of video and audio sensors, for example, can be utilized to create new monitoring and surveillance systems or to improve current ones. In times of crisis and war, essential locations for homeland security, such as borders, gulfs, strait entrances, and port approach waters, are vulnerable to enemy infiltration. Using an instantly deployable network of sensor nodes in these operation regions would be a good way to boost the probability of detecting an infiltration in a cost-effective and appropriate manner. Military operations, for instance, place stricter requirements on sensor and ad-hoc networks, such as reliability and real-time operation.

Due to the limited battery life of the nodes, efficient energy consumption approaches are required, which poses a real-time and reliability problem. There are numerous routing options that can achieve one or both goals of lowering end-to-end time and ensuring reliability. However, most of these routing systems have issues with other parts of the system, such as energy efficiency, extended life, and low cost. Most energy-aware protocols in the literature use multi-hop pathways to save energy. With data sensor

technology, a wireless sensor network is being created for self-established network infrastructure. It can simplify device development in both small and large areas. Sensor data can be used to monitor a variety of data, such as water, humidity, temperature, and so on. These could be the key to sustaining a variety of businesses, including agriculture. Farming is one of the few historical human activities in which innovation and technology have been accepted with difficulty, until real and immediate solutions to specific problems or improvements in production and quality are discovered. However, a new approach for gathering information in the atmosphere might be a critical step toward high-quality, environmentally responsible agriculture.

Irrigation, fertilisation, and pesticide administration are all tasks that are usually entrusted to the player. Agronomists' attention: common qualities that help to ensure Plant growth and tradition are generally offering a wider picture. Chemical substances and plain water are consumed in excess. There are no one-on-one responses to the choice. There are consequences when it comes to healing or irrigating plants, as well as in the actual world. In every area of the field, growth challenges are frequently centred on rare and remote weather channels that are unable to provide acceptable and local proportions of the standard criteria. On the other hand, agronomic types produced by these types of supervised files are unable to produce trustworthy data. Agriculture, on the other hand, demands painstaking monitoring in order to gain real-time reactions between vegetation, local climate diseases, and man's options. A Cellular Sensor Network programme is usually the best technology to match a superb inconspicuous approach of monitoring the surroundings. WSN adoption must address both programme level issues (e.g., unattended operations, longest circular life, adaptability or even self-reconfigurability of uses and protocols) and residual consumer desires in order to be successful in gardening management (e.g., connection trustworthiness and robustness, simple to use, flexible, and highly effective aesthetic consumer interfaces). Your supply of stand-alone businesses is the one that is most tightly linked.

To accomplish this, the machine must be able to run unattended for long periods of time, and nodes must be put in difficult-to-maintain locations. In this case, the most efficient utilisation of energy is required. Strong surgical issues are another requirement, which usually demands failure administration because the node can fail for a variety of reasons. The network's general scalability and adaptability in terms of the number of nodes and their stability in unexpected conditions, as well as increased responsiveness and reconfigurability, are also key qualities. Finally, several user-oriented issues such as fairness, latency, throughput, and enhanced files querying plans should be taken into account, even if they are often viewed as supplemental to each of our programme activities as the WSN's cost/performance trade-off. With the example in mind, your previously specified needs necessitate a well-designed and optimised overall programme.

2.1 | A Wireless Sensor Network Security Method

This security method for WSNs covers the agriculture sector's challenge, user approach, and technological implementation. These methods serve as a foundation for implementing security in the future. Although each sort of agriculture demands a different response, the agricultural area can be built on a general framework and foundation. The farm industry's challenge includes factors such as location, device handling, activities, and personalities. Agriculture can be classed based on where it is produced. It is unlikely that the infrastructure and technical platform will be deployed in rural areas. It's simply a matter of establishing a wireless sensor network and relying on it for data transmission and security.

2.2 | System set up

In the existing system, all of the components required for this system are currently implemented manually. For example, if a person wants to learn about a specific field's agriculture land profile, he must drive to a faraway location. As a result, doing so has proven to be challenging. This proves the utility of wireless sensor network applications in agricultural contexts. Traditional systems require a significant amount of time and workers to monitor environmental data provided through cable. As a result, real-time

environmental monitoring data is exceedingly difficult to obtain, owing to the difficulties of laying lines, the high cost of investment, and man-made devastation, among other things.

2.3 | System to be proposed

A wireless agricultural environmental monitoring system based on WSNs is required to address existing system limitations. It has three major advantages: 1. Data gathering is highly accurate due to the densely dispersed nodes. 2. Sensor nodes with a certain calculation and storage capacity, 3. As well as the ability to collaborate among nodes, are ideal for the environment and can be achieved via a wireless sensor network.

Fig. 1. Module for an integrated board.

2.4 | Limitations

Hundreds or thousands of sensors are a significant hardware constraint in WSN systems. We will only have an ATMEGA8535 processor and an Ic-S8817 BS Analog to Digital converter in this system, as shown in the hardware structure of the node in *Fig. 2*, so we will not be able to test our software with a large number of sensors, but this will be sufficient for proof of concept implementation. A Zigbee-based wireless transceiver module is used by WSN.

3 | Design in Depth

Programming the sensor nodes, programming the gateway, and informing the greenhouse / agriculture field manager are the three major functions of this system, according to the product. The information at the gateway is communicated to the greenhouse management via a user-friendly web site and SMS messaging, and the sensor nodes offer complete data.

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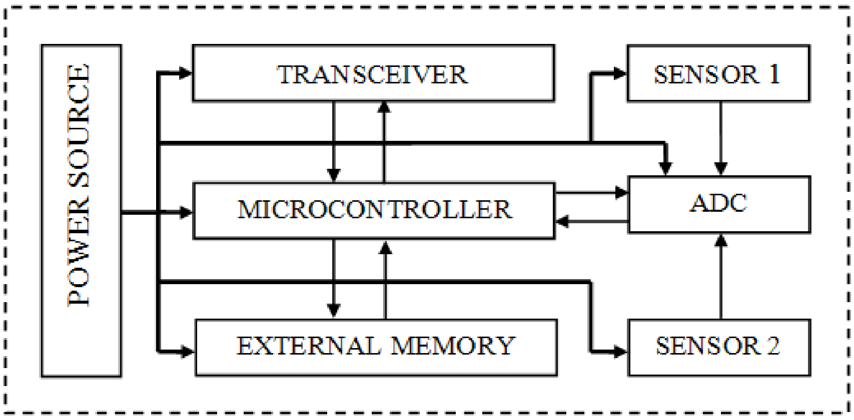

Fig. 2. The node's hardware structure.

Sensor Nodes Programming.

Temperature readings are taken on a regular basis by sensor nodes and relayed to the gateway. They should, however, make these observations with as little energy as possible. As a result, in this assignment [7], power-saving routing algorithms for sensor networks will be developed. Three basic activities must be completed in order for this task to be completed. Correct the errors in the data from the sensor nodes first. After that, combine the data. Finally, store the data to the gateway's associated PC's SQL database. This tool will provide a user-friendly interface for greenhouse management, allowing the manager to simultaneously study pertinent information about his or her farm. Users can also compare historical and current statistics using this web application.

3.1 | Topology of Stars

This component is classified as a subsystem component. The primary function of this component is to send the data acquired by the sensor nodes to the gateway. The most major drawback is the component's energy consumption. Because energy use will necessarily demand repair, this component must be energy efficient. The system's dependency on the gateway's good operation is another important shortcoming of this component. The entire system fails if the gateway or a computer connected to it fails. The network's performance and scalability are determined by the gateway's capabilities. The network size is limited by the number of connections that can be established to the gateway. We won't be able to scatter the sensor nodes throughout a vast territory because all sensor nodes will transmit their data to the gateway instantaneously. The network can be conceived of as a collection of diverse sensor nodes in a star topology. Each node performs the same function. The processing section goes through the specifics of the sensor node processing.

The network component is a separate subsystem with its own sphere of operation. It gathers information, processes it, and sends the results to the gateway. As a result, it communicates entirely with the gateway system. Any side effects induced by other components working in stable states are eliminated since the component preprocesses the observed data. A radio board, a sensor board, and a battery are all included in each sensor node. Each sensor node has its own CPU and memory. Because the sensor nodes are embedded devices, they have limited resources. As a result, interaction code with them should be as simple as possible. When there are no obstructions in the path, such as a wall or a tree, radio boards can carry signals up to 300 metres. The batteries used are 6V lithium-carbon batteries, and we make every effort to extend their life. There are no race concerns or deadlock scenarios because each sensor node is serviced by a single thread. The sensors take readings at predetermined intervals and send the data to the gateway. Each sensor node then rests until the moment it must perceive arrives; the timing is set in advance and can be adjusted as needed. In this system, the time for the star topology-based protocol is set at 5 minutes by default. Because they are programmed as a single thread within an unending loop, sensor nodes have no concurrency.

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The following steps are:

Step 1: Detect the surroundings,

Step 2: Send the info you've collected to the gateway,

Step 3: Sleep for a set amount of time,

Step 4: Return to the first step.

The algorithmic complexity of this component is unquestionably O. (n). The space complexity of this process is relatively minimal, even for sensor nodes [12], because there is no dynamic data creation. As described in the section "Data description of Sensor Nodes for Star Topology" of this page, each sensor node only sends one field to the gateway. Furthermore, because, as pseudo code indicates, each sensor node has a very particular role that can be implemented in a little source code file, the memory code section will be fairly small. There is no exception handling on the sensor network components. Even if the sensor nodes fail to deliver data or send it improperly, the gateway will take care of everything.

As previously stated, the network merely connects with the gateway. From the network to the gateway, this is a one-way communication. The interface of each sensor node is a network packet. This packet is a C structure named Packet to Gateway that contains the following information: the sensor id is represented by 1. Each sensor has a unique id, which the gateway uses as the database's primary key, 2. Stores the battery level as an integer between 0 and 100. Temperature: saves the most recent temperature measurement.

4 | Web Application

Classification: This component is classified as a subsystem component. Responsibilities: The most important responsibility of the web application is to provide a user-friendly environment. For the end user, the interface should be straightforward to understand. It must be secure; user data must not be available to third parties. Maintaining database integrity is crucial. Switching the database management server should be straightforward. Furthermore, changing the database structure without changing the interface should not cause any problems. There aren't many limitations when it comes to the web application component. The intended market for this project is somewhat small, and many existing servers are more than capable of servicing user requests. These aren't even CPU-intensive queries; they're just database fetch requests. The component's design is object-oriented. This design has five different classes: 1. Web-based programmes: Description This class starts the web application and keeps it running in the background at all times. 2. Notify users: This class will operate as a daemon thread that will periodically check the database and notify users as needed. 3. Database: This adapter connects to the database, executes the user's instruction, and returns the result. 4. User: The user is represented by the user class. There will be a separate thread for each user. As a result, the User class is only natural to extend Thread. 5. Agriculture: The greenhouse class has the capabilities show Instant Data and show Previous Data. When the user requests data, this message is sent to the Greenhouse instance in the user class. The instance then establishes a database connection and executes the request using its capabilities. 6. Interaction/Uses: This component is communicated with by the gateway subsystem. The database is used to make interaction easier. This component also interacts with the user. This is the one component that allows users to interact with the entire system. A graphical user interface is used by the user to engage with the online application (GUI). The system's other components are untouched by the side effects of the user engagement. 7. Materials: The web application subsystem requires some resources. To begin, information is saved in a separate database. A database management server will also be necessary. A web server is also required to host the database and application. The application has no race conditions or deadlock difficulties. Because a single user can only connect to parts of the database that are mutually exclusive, a single user can only connect to bits of the database that are mutually

exclusive. As a result, several user threads are no longer need to wait for each other. 8. Web application processing: The web application has two processes. The first stage starts when a user registers with the system and is guided by the user's interactions with the online application. The second phase occurs on a regular basis, regardless of the user. The next sections go into the details of these two operations.

Processing of the user-website interaction.

This operation is started by the user typing the site URL into a browser. When a visitor comes to a website, the web server creates a unique connection thread for them and takes them to the home page. The main page is a normal login screen with fields for entering a username and password. For those who have forgotten their account or password, there will be a password reminder option. The user must first enter his or her email address before using the password reminder option. After matching the user with the email address in the database, the user's username and password are sent to that address. After logging in, the user is transported to a screen that displays his greenhouse list, continuing with the main flow. This page also includes a link to the user's preferences page, where the user can make changes.

Alternate flow 1.

The user selects one of his greenhouses and is directed to its webpage. This page has three functions. The user is first shown the most recent greenhouse measurements that have been loaded from the database. By entering time intervals in the boxes on this page, the user can request historical measurement data in the form of a list or a graph. Finally, the user has the ability to change the greenhouse's critical measuring settings.

Alternate flow 2.

The user goes to the preferences page. On the settings page, the user can make changes to any of his information. On the settings page, the user can also change his notification preferences. The user can choose whether or not to receive notifications through text message or e-mail, or whether or not to receive any notifications at all. The user can log out after completing his or her assignment. It's worth mentioning that every page will have a log out option. The thread associated with a user is closed when that user signs out. To avoid resource leakage, if the user fails to log out properly, the session will be terminated after one hour.

The regular database check is processed as follows.

Another function of the web application is to notify the user when an unexpected event occurs. This can happen in one of two scenarios. To begin, the most recent temperature or humidity reading is either excessively high or excessively low. Second, the sensors' batteries have failed in the majority of them, forcing the sensor network to fail. This regular database check is performed by a daemon thread that runs in the background. Every 5 minutes, this thread examines each greenhouse and notifies the owner using the notification mechanism that the owner has already defined.

Because this is a simple web application, there are no CPU-intensive advanced algorithms to consider in terms of temporal complexity. The theme is unconcerned about the passage of time. Complexity of space is also not an issue. Users' actions do not add a significant amount of data to main memory, and RAM is reclaimed when the user's requested page is displayed. There will undoubtedly be concurrency issues due to the presence of a multi-threaded system. We don't know how many user threads an ordinary web server can handle right now; nevertheless, this is a hardware issue that will be handled only once the testing period is completed. When multiple users attempt to obtain data from the database at the same time, a concurrency problem emerges. The solution to this problem is a Database Management System (DBMS). The solution to this problem is a DBMS. As noted throughout the study, exceptional business logic problems will be addressed with. Apart from that, if the system stops working properly or if massive

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resource leaks develop over time for reasons we can't conceive of right now, the web application will check the situation and, if necessary, restart the system.

Interface/Exports.

The web application communicates with the rest of the system via the database. Between this component and the gateway component, this database serves as a communication point. The user interface serves as a conduit between the web application and the end user. Menu Form: "Menu form" is displayed if authentication is successful.

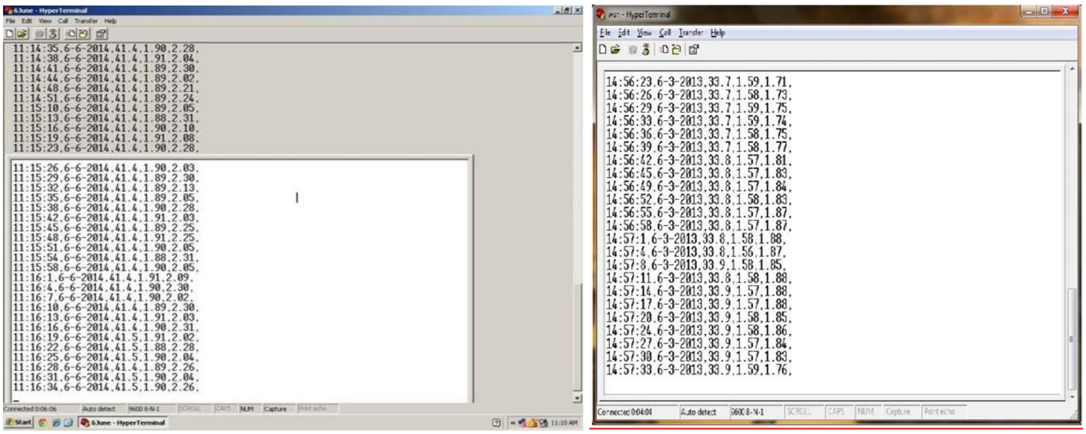


Fig. 3. Data recording in the years 2014 and 2013.

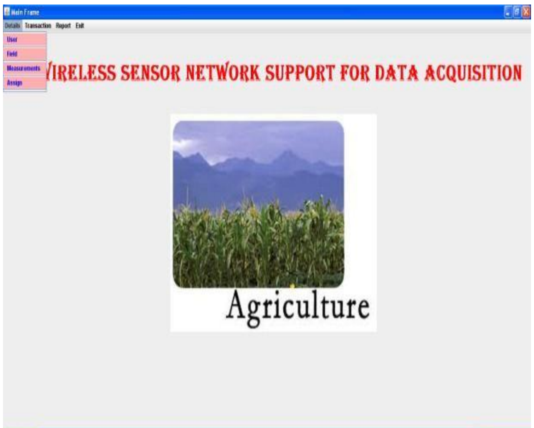


Fig. 4. Menu form. **Fig. 5. User details.**

User Details: If you choose "user details" from the "Details" menu, the form that appears is as follows. Field Details: If you choose "field details" from the "Details" option, the form that appears is as follows.

Fig. 6. Field detail.

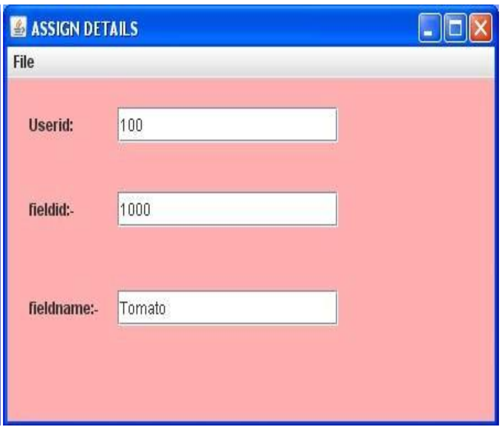


Fig. 7. Assign details.

Assign Details: If you choose "assign details" from the "Details" menu, the form that appears is as follows. Transaction- Selection Form: If you choose "selection form" from the "transaction" option, the form that appears is as follows.

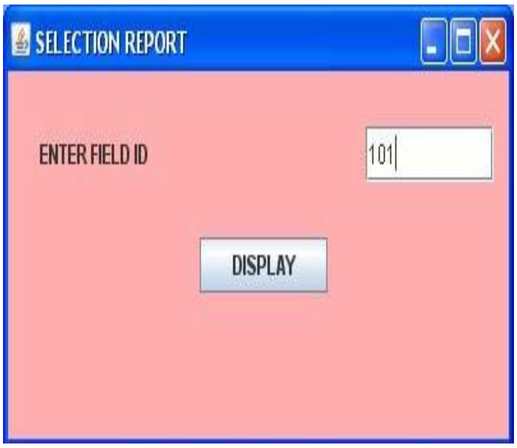
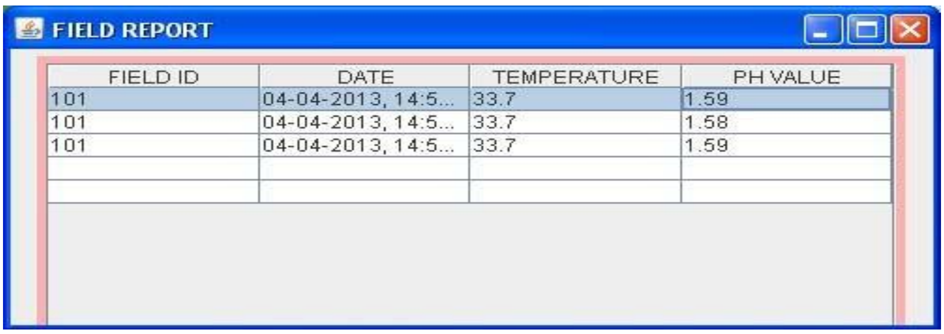


Fig. 8. Selection form.

Fig. 9. Previous report.

As soon as the field id is selected reports get generated

Previous Reports: If you choose "prior reports" from the "Reports" menu, the form that appears is as follows



FIELD ID	DATE	TEMPERATURE	PH VALUE
101	04-04-2013, 14:5...	33.7	1.59
101	04-04-2013, 14:5...	33.7	1.58
101	04-04-2013, 14:5...	33.7	1.59

Fig. 10. Selected field previous report.

5 | Conclusion and Future

Protecting agricultural land from weather effects, pests, and other factors makes a lot of sense for farming productivity. For green house atmospheric tracking and control, high-quality automation is needed. The

application of WSN technology innovation to agricultural land is a growing trend for farm security that also overcomes the limitations of wire connection systems. This study outlines the whole WSN system architecture as well as the data architecture. The designs of the subsystems/modules are included. This strategy gives the area's developers with nearly all of the information they require. Incorporation into the actual world (feasibility and simulation). Examine the sensor nodes' critical state (solving the problems of node failure, routing and self-recovery etc.) Implement a web-based application for analysing raw data.

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